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ABSTRACT

This paper provides a brief overview of Problem-Based Learning (PBL) as an instructional methodology. A description of a graduate program for practicing teachers at the University of Colorado at Denver (UCD) is also included. Problem-based learning is a student-centered instructional methodology that teaches content and skills within a knowledge domain by using substantive, carefully-crafted problems or challenges as the stimulus and focus for student activity. The students work with problems in a manner that fosters reasoning and knowledge application. The master's program in information and learning technologies at UCD is designed for classroom teachers using PBL as their primary instructional strategy. The main emphasis of the program is to help teachers learn to integrate information and learning technologies in student-centered ways in the classroom. Program issues, problems, successes, and lessons learned are discussed, including: group size and student-teacher ratio, infrequent class meetings, projects versus problems, project time commitment, and assessment and grading. (Author/SWC)

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Problem Based Learning at the University of Colorado at Denver

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This paper provides a brief overview of Problem-Based Learning (PBL) as an instructional methodology. A master's program in information and learning technologies, designed for classroom teachers using PBL as its primary instructional strategy is then described. Information about program issues, problems, and successes is provided.

Problem-Based Learning

Problem-based learning (PBL) is a student-centered instructional methodology that teaches content and skills within a knowledge domain by using substantive, carefully-crafted problems or challenges as the stimulus and focus for student activity (Boud & Feletti, 1991). Employing the principles from a constructivist view of learning, PBL prepares students to meet the challenges of their professions (Barrows, 1985, 1986; Bridges, 1992; Gijselaers, 1995a, 1995b; Savery & Duffy, 1995):

- Students acquire an essential body of retrievable and usable knowledge and skills;
- Students develop problem-solving and reasoning skills that transfer to other situations;
- Students develop lifelong learning skills (i.e., metacognitive and self-directed learning) to extend and improve their knowledge base in order to remain contemporary.

To meet these educational outcomes, PBL uses problems, or challenges, as starting points for learning (Boud, 1985, p. 13). This is different from conventional classrooms which use problems as culminating activities after the teacher presents content. In a PBL environment, the teacher presents students with authentic, ill-structured problems *before* they receive any instruction. During the process of working on the problem, students build substantial knowledge bases through increasingly self-directed study. Students identify areas of learning to guide their own individualized study. The skills and knowledge acquired through individualized study are applied to the problem to evaluate the effectiveness of learning and to reinforce learning. Through collaboration with classmates, students refine and enhance what they know. When a solution is at hand, they present, justify, and debate solutions, looking for the best possible resolution to the problem.

Content learning and skills development occur as natural consequences of solving the problem, much the same way people in the workplace learn on-the-job. In fact, in a PBL environment, students take on the roles of scientists, doctors, historians, programmers, engineers, advertising executives, mechanics, or any others who have a stake in the problem. Therefore, the students work with problems in a manner that fosters reasoning and knowledge application.

University of Colorado at Denver Master's Program

The Information and Learning Technologies program in the Division of Technology and Special Services at the University of Colorado at Denver (UCD) offers a master's degree program for practicing teachers. The primary emphasis of this degree program is to help teachers learn to integrate information and learning technologies in student-centered ways in their classrooms. The general features of the program include:

- An extensive program design process including several iterations based on feedback from an external advisory group,
- Instructional strategies focused on problem- and project-based tactics,
- Classes offered on intensive weekends in six semester-hour blocks. Students meet for 15 hours on alternate weekends including Friday evening, Saturday, and Sunday morning,
- Extensive use of e-mail during the two weeks between classes to discuss general issues and to communicate with subgroups, and
- Most classes are held off-campus in technology labs in schools in which the students teach, enabling students to visit many different facilities.

The content our on-campus master's program was reorganized into six semester-long blocks of three to six credit hours. We took into account the feedback we have received over the past few years from classroom teachers in

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our on-campus program, the advisory board, and our research on the skills, knowledge, and strategies that classroom teachers ought to have to be effective and integrated users of technology. The blocks are described below:

- Technology as a Learning Tool (6 hours): Program orientation, constructivism, PBL philosophy and values, action learning, networking skills, HyperStudio, video production, the Internet and other electronic networks
- Technology Tools and Issues (3 hours): Design and operation of networks, troubleshooting and management of technology, security and other tools
- Integrating Technology in the Classroom (6 hours): Instructional design processes, rich environments for active learning (REALs), state model content standards, special needs, and integration of technology into the curriculum
- Creating Learning Communities (6 hours): Knowledge-building communities and rich environments for action learning, WWW use for instruction, and web page design
- Developing Interactive Media (6 hours): Principles for designing, creating and evaluating interactive and multimedia instructional hypermedia and multimedia materials for CD-ROM
- Leadership and Change (3 hours): Diffusion and adoption strategies, fund raising, leadership skills

Students are required to complete six additional hours through transfer credits, conference attendance, internships, and on-campus courses. Comprehensive exams are in the form of an individual master's project and a master's portfolio. Class time is spent on these projects during the final semester.

From the beginning of development, the faculty in the ILT program made a commitment to using constructivist strategies in teaching the courses in the program. Our primary choice was problem-based learning. This brought about some unique issues as we learned to apply the PBL approach to a large group of people who only meet once every two weeks. We discuss those issues below.

PBL and Large Groups

Most PBL programs are conducted with small groups who meet frequently with tutors. We didn't have that luxury. There are 20 people in the program and one teacher/tutor. The tutor is critical in helping students reflect on their learning and to remain faithful to the PBL process, so we had to learn how to conduct that reflection and monitor the process either in our absence or with a single large group. Strategies that we tried include:

- Rather than meet with each group individually, we had the small teams prepare for reflection discussions by writing answers to reflection-based questions individually. Then we gave the teams time to discuss their individual responses together. Finally, we brought all the teams together to share their thoughts.
- Infrequently (when there were two of us on site) we met with individual teams, mostly in an effort to monitor the process. Teams tend to fall victim to "production bias." That is, teams tend to want to solve the problem, produce a product, or "win the race" and avoid things that get in the way of "producing" – things like taking time to reflect on their learning.
- Since the students met only once every two weeks, we gave up significant portions of class period to team meetings and team work. To compensate for missed class time, we used e-mail discussions focused on reflection questions during the times between classes.
- We gave reading assignments during class so that part of the class would have something meaningful to do while a team or individuals worked with a teacher.

Even though we strongly supported the PBL approach and were prepared to make changes, giving up class time for other activities was (is) one of the hardest things to learn to do. Learning comes from working on the problem and from reflecting. Even after three semesters, we are still learning and thinking about how to handle class time. We'd feel more comfortable if we had more time to meet with the individual teams.

Infrequent Class Meetings

Most PBL programs have several meetings per week. We met once every two weeks. To facilitate the PBL approach, we gave up significant amounts of class time for small group meetings. This continues to pose problems for us. The teams need to meet together more frequently and the distances several of the students had to travel made this difficult. E-mail is not always effective. Many of the students waited until the Thursday evening before the next class (Friday evening) to read and respond to the question of the week, leaving little time for thoughtful reflection and reaction from their peers. Some of the strategies we tried include:

- We created small groups based on geographic proximity. This enabled them to get together between class sessions. However, one group was composed of people in rural locations. They were not able to get together.
- We gave up class time for team meeting time.

- We worked on class norms for e-mail discussions (short, single-topic responses, earlier and more frequent reading of e-mail). In fact, we used this strategy a great deal. When we encountered problems in the class, we asked the students to verbalize those problems and then to develop solutions that they would all agree to follow.

"It's Reflection Stupid" or Projects vs. Problems

One of the things that we as teacher-facilitators learned that probably had little effect on our students is that there is a difference between projects and problems. In general, a problem is more open-ended than a project, leaving almost all decisions about where to go with the problem to the students. A project is more narrowly defined and may specify the nature of the final product or solution. Part of this dilemma occurred because our students felt a need to have everything spelled out, turning what was intended to be a problem into a project – it takes time to develop the trust among students and between students and teachers necessary to accept the notion that multiple solutions are OK. We felt kind of guilty about this at first, thinking we were failing in our approach. But we came to the conclusion that sometimes a project is more appropriate than a problem, especially if you are trying to teach specific skills that a problem would allow the students to avoid. The purpose of both a problem and a project should be learning through reflection. We believe there is a role for each as long as reflection is not short-circuited. Two of our most successful examples from each category follow:

Example Problem: (We took this problem from the newspaper.) Your school board has decided to suspend all spending on technology until evidence is produced that technology has a positive effect on learning. You are teachers in the district. Your task is to prepare a 20 minute presentation supporting or arguing against the school board's decision.

Example Project: (We took this from student needs. They became extremely interested in student-centered learning strategies and wanted to learn more about them.) We assigned each of six groups one student-centered strategy. They researched the strategy and created a HyperStudio stack about the strategy that they other groups used. Strategies included: PBL, reciprocal teaching, integrated learning, cognitive apprenticeship, authentic instruction.

Overwhelming

Our notion of doing the program with intensive weeks in large blocks was appealing to our students. Yet, it took us, as teachers, half the program to figure out how to deal with it. For example, we thought that a class that was 6-credit hours long should deal with at least three problems/projects. And, in our effort to appear organized, we prepared the problems ahead of time and presented them all at the first class. It was difficult enough for us to organize 15 hours of class per weekend and then try to subdivide that into time for three separate projects and any other material we wanted to deal with. The students had the same organizational problem, not knowing how to divide their time away from class. They were always overwhelmed. They also tended to want to put in much more time than we wanted them to for each project.

Assessment

Assessment and grading continue to be a problem. As teachers, we constantly wrestle with the conundrum of not believing in grades, but since the university requires them we believe they should mean something. This becomes a greater problem in a problem/project environment based on small groups where everything is always in process and feedback is supportive rather than judgmental.

Cooperative learning and PBL experts recommend both individual and group accountability. Yet, in the area of group accountability we found that our students continue to be reluctant to comment on the participation of others and avoid evaluating their group members. We tried face-to-face meetings with the team, personal forms and anonymous forms, both group grades and individual grades. We were satisfied with nothing we tried. There may be two contributing factors to this: first, our students quickly developed such close relationships that they worked hard to support each other and would not let each other down. In fact, this was a cohort group and they knew they were going to need to work with each other for two years. Second, we took considerable time to prepare them for working in teams. This preparation included the following activities:

In our first class, we asked students to write down five things that they dislike about working in small groups. Our students are graduate students and they've been exposed to small group work many times in class and at work. Generally students dislike it.

We then asked students to share their lists. It doesn't take long before you develop a list of about 10 items that take into consideration almost all complaints. While developing the list, with each student complaint, we then

ask for ideas on how to deal with the complain so that it does not become a problem. So, we ended up with a list of about 10 problems and several solutions. Some of the common problems include:

- What do we do with the non-participant?
- How do we handle the person who has a story about everything?
- What will we do when someone is not pulling their weight?
- How may hours a week can we each give to this project?
- What do we do if someone doesn't perform the work assigned?
- How do we handle the negative person?
- We then created the first teams, attempting to balance personalities and geographic locations.

Each team then took a worksheet based on the complaints about group work and developed a plan for dealing with each problem. We made it clear to each team that communication and work problems were to be dealt with by the team, not the teachers. We found that the very process of discussing potential problems and creating team policies for dealing with the problems prevented almost all future problems. Expectations and standards were set and each team member signed-off on the policies.

Despite the progress made during the first semester, we found that it was important to continue reviewing our standards and basic PBL principals. Several of the students, even though they intellectually agreed with the structure of the class, continue to push for more traditional structure and guidelines.

Lessons Learned

As we plan for the next cohort, there are a few decisions we have made, based on what we have learned from the first cohort.

- Both students and teachers are better at dealing with one problem or project at a time. Therefore:
- The courses for our next cohort will be arranged around problems or projects.
- Rather than traditional 3- or 6-hour courses, we will assign credit hours based on the needs of the problem – anywhere from one to four.
- Courses will not follow the university calendar, but follow one after another, so the students are only taking one class/problem/project at a time.
- As we plan the courses, we will make a decision as to whether a problem or a project is more appropriate for the skills we are targeting.
- Shorten the length of the weekend meetings. By Sunday morning we were all washed up. We had some fruitful Sundays, but not always.
- Target a student population that is closer to the university, making between-class meetings more practical.

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